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Original Contribution

The Aftermath of Hip Fracture: Discharge Placement, Functional Status Change, and Mortality

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The authors prospectively explored the consequences of hip fracture with regard to discharge placement, functional status, and mortality using the Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD). Data from baseline (1993) AHEAD interviews and biennial follow-up interviews were linked to Medicare claims data from 1993–2005. There were 495 postbaseline hip fractures among 5,511 respondents aged $\geq$69 years. Mean age at hip fracture was 85 years; 73% of fracture patients were white women, 45% had pertrochanteric fractures, and 55% underwent surgical pinning. Most patients (58%) were discharged to a nursing facility, with 14% being discharged to their homes. In-hospital, 6-month, and 1-year mortality were 2.7%, 19%, and 26%, respectively. Declines in functional-status-scale scores ranged from 29% on the fine motor skills scale to 56% on the mobility index. Mean scale score declines were 1.9 for activities of daily living, 1.7 for instrumental activities of daily living, and 2.2 for depressive symptoms; scores on mobility, large muscle, gross motor, and cognitive status scales worsened by 2.3, 1.6, 2.2, and 2.5 points, respectively. Hip fracture characteristics, socioeconomic status, and year of fracture were significantly associated with discharge placement. Sex, age, dementia, and frailty were significantly associated with mortality. This is one of the few studies to prospectively capture these declines in functional status after hip fracture.

activities of daily living; hip fractures; mobility limitation; mortality; patient discharge

Abbreviations: ADLs, activities of daily living; AHEAD, Survey on Assets and Health Dynamics Among the Oldest Old; IADLs, instrumental activities of daily living; TICS, Telephone Interview to Assess Cognitive Status.

Hip fracture is a major health problem that occurs frequently (325,000 annually) in the United States (1), is expensive ($20 billion in 2006), and results in greater morbidity, significant disability, reduced quality of life, and increased 1-year mortality (18%–33%) (2–11). However, the existing literature on the aftermath of hip fracture (9, 12–16) relies on small samples identified at the point of hospital admission. Such studies lack prospectively collected prefracture data on prior health and health behavior, disease history, and functional and cognitive status. Most rely on retrospective assessments or comparisons of postfracture patients with ''normal'' controls, and few have simultaneously considered sociodemographic factors, socioeconomic status, place of residence, health behavior, disease history, and functional and cognitive status covariates in the same analyses.

The aim of this study was to examine the aftermath of hip fracture, including discharge placement, change in functional status, and mortality, in a large, nationally representative sample. Therefore, we used baseline (1993) and biennial follow-up data collected through 2006 from the Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD) that we linked to Medicare claims data from 1993–2005. This provided us with information on an extensive array of potential covariates and allowed us to evaluate

prospectively obtained pre- and post-hip-fracture functional status assessments.

MATERIALS AND METHODS

Sample

AHEAD is a national, omnibus health and retirement longitudinal data source available for public use (17). Participants were identified either from household screening conducted during 1992 multistage cluster sampling for a companion study of pre-retirement-age adults or from a supplemental sample of persons aged ≥80 years identified from the Medicare Master Enrollment File (18, 19). Oversampling was used to increase numbers of African Americans, Hispanics, and Floridians; therefore, all analyses in the current study were weighted to adjust for the multistage cluster sampling design and/or the oversampling. Baseline interviews were conducted in 1993 with 7,447 participants aged ≥69 years (response rate = 80.4%) (19, 20). Participants were reinterviewed in 1995, 1998, 2000, 2002, 2004, and 2006 (21, 22).

We identified hip fracture cases in a subsample of AHEAD participants. Of the 7,447 baseline participants, 802 (10.8%) could not be linked to their Medicare claims, another 604 (8.1%) were in managed Medicare, and another 530 (7.1%) were proxy respondents. AHEAD participants for whom a proxy provided baseline information were excluded, because cognitive and psychosocial data were not ascertained for them. Participants in managed care were excluded because these plans do not have the same data reporting requirements as fee-for-service plans (23). We adjusted for the potential selection bias introduced by these exclusions using propensity score methods to reweight the data (22, 24–27). Among the remaining 5,511 AHEAD participants, 495 participants were hospitalized at least once for a postbaseline hip fracture (i.e., *International Classification of Diseases, Ninth Revision, Clinical Modification*, admitting diagnostic code 820.*xx*), and their first postbaseline hip fractures constituted our analytic sample.

Placement status and mortality

Placement after discharge was determined using the patient discharge status code from the Medicare inpatient claim. Discharge status was categorized as deceased (inpatient mortality) or discharged to home, an inpatient rehabilitation facility, or a nursing facility. The home placement group included persons who had been discharged to home care/self-care, to the care of a home health service organization, to the care of a home intravenous drug therapy provider, or to home hospice care. The nursing facility placement group included persons who had been discharged to a skilled nursing facility, an intermediate care facility, a hospital-based Medicare-approved swing bed, or another nursing facility. The inpatient rehabilitation placement group included persons who had been transferred to another short-term general hospital or a different type of institution for inpatient care, transferred to an inpatient rehabilitation facility (or the designated rehabilitation unit of a hospital), or transferred to a long-term acute-care hospital (28). Post-discharge mortality was based on the death date listed in the Medicare claims denominator file.

Functional status

Functional status was determined using 9 clinically relevant standard outcome measures available in the AHEAD data (29). The index of activities of daily living (ADLs) is a 5-item index that includes difficulty with bathing, eating, dressing, walking across a room, and getting into or out of bed. The index of instrumental ADLs (IADL) is a 5-item index that includes difficulty with using a telephone, taking medication, handling money, shopping, and preparing meals (30). The mobility index is a 5-item measure that assesses difficulty in walking 1 block, several blocks, or across a room, climbing 1 flight of stairs, or climbing several flights of stairs. The large muscle index is a 4-item measure that assesses difficulty in sitting for 2 hours, getting up from a chair, stooping, kneeling, or crouching, and pushing or pulling a large object. The gross motor skills index is a 4-item measure that assesses difficulty in walking 1 block, walking across a room, climbing 1 flight of stairs, and bathing. The fine motor skills index is a 3-item measure that assesses difficulty in picking up a dime, eating, and dressing. The self-reported health status measure (31) asked participants whether they would rate their health as excellent (95), very good (90), good (80), fair (30), or poor (15); the numbers shown in parentheses are the Diehr et al. (32) values. Depressive symptoms were assessed using the 8-item Center for Epidemiologic Studies Depression Scale, scored as the sum of depressive symptoms experienced "all or most of the time" (33). Cognitive status was measured using the Telephone Interview to Assess Cognitive Status (TICS) (34). Although there is some overlap among these measures, the use of all 9 allows a more precise assessment of functional status.

Changes in functional status

Changes in functional status were calculated only for participants whose hip fractures occurred between adjacent waves of scheduled interviews for which they were self-respondents. That is, participants had to be self-respondents at the interview immediately prior to and immediately after their hip fracture. For ADLs, IADLs, fine motor skills, self-reported health, and Center for Epidemiologic Studies Depression Scale score, our sample included 209 persons with an average of 2.1 years between the pre- and postfracture measures. The 286 other persons had missing information on these indicators because of the use of a proxy respondent at either the pre- or postfracture interview or at both (110 or 38.5%), death prior to the following survey (111 or 38.8%), or loss to follow-up (65 or 22.7%).

One or more items in the mobility, large muscle, and gross motor skills indices were not assessed in the baseline survey, and thus this information could not be determined for 44 hip fracture cases occurring prior to the 1995 follow-ups. For an additional 85 (17%) of the 495 hip fracture

cases, changes in the TICS could not be determined because of age-related increases in missingness as the AHEAD cohort aged (34).

Covariates

Hip fracture characteristics were obtained from the Medicare inpatient claim and included fracture location (pertrochanteric, femoral neck, or not specified), type of surgical procedure (pinning, replacement, or no procedure), length of stay, and secondary diagnoses (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes) categorized according to Agency for Healthcare Research and Quality clinical classification software (35). Other patient-level characteristics included in the multivariable models were chosen on the basis of prior reports of effects on discharge or mortality after hip fracture (12, 13). Baseline sociodemographic factors included age, sex, and race/ethnicity. Socioeconomic factors included education and number of health insurance policies. Other factors included number of comorbid conditions (e.g., previous self-reported history of angina, arthritis, cancer, or diabetes) and health behaviors such as body mass index (weight (kg)/height $(m)^2$), smoking history, and alcohol use. In addition to these static (baseline) factors, we also assessed several time-dependent covariates, including living alone, marital status, type of dwelling, self-reported health status, ADLs, and cognitive status as self-reported at the interview closest in time to but prior to the hip fracture.

Statistical analyses

Multinomial logistic regression (36) was used to predict the probability of the discharge placement (excluding in-hospital mortality) because discharge placement is a categorical outcome with 3 placement groups (home, inpatient rehabilitation facility, and nursing facility). The ''nursing facility'' group was the reference category. Multivariable proportional hazards regression (37) was used to model time from hip fracture to death. Changes in functional status were continuous variables measured as the change in score (score after hip fracture minus score prior to hip fracture) for each index. Therefore, linear multivariable regression was used to model changes in functional status (38). Multivariable model development (multinomial logistic, proportional hazards, and linear) involved the simultaneous inclusion of hip fracture characteristics and other patient-level characteristics into iterative forward, backward, and stepwise model selection procedures (39, 40). Final models included factors previously found to be predictive of that particular outcome and all other factors independently significant at the 0.05 level or beyond.

Institutional review board approval

The study protocol was approved by all applicable oversight groups, including the AHEAD restricted data access board, the University of Iowa institutional review board, and the Center for Medicare and Medicaid Services.

RESULTS

Descriptive data

Subjects. The 495 hip fracture cases were uniformly distributed over the study. The mean age at hip fracture occurrence was 85 years (standard deviation, 5.8); 73% of fracture patients were white women, 8% were minorities, and half lived alone. Educational attainment was diverse, with 31% of participants attending only grade school and 27% attending college. Two-thirds reported annual incomes less than $20,000, and 40% reported total wealth less than $15,000. Half had never smoked, 40% were former smokers, and 10% were current smokers. Approximately half (54%) of the subjects had normal body mass indices, with 7% being obese and 6% being underweight. Twenty percent had none of the 11 morbid conditions at baseline, and 23% had 3 or more. Fair or poor self-rated health was reported by 44%, and 52% had good or better scores (>12) on the TICS. There were 1,506 person-years of surveillance (time from hip fracture to death or censoring; mean person-years = 3.0 per person).

Fractures. Table 1 shows that pertrochanteric fractures were most common (45%). At least 20% of the subjects had 1 or more secondary diagnoses of osteoarthritis, falls, delirium, or fluid and electrolyte disorders. Surgical pinning (55%) was more common than hip replacement (39%). The mean length of hospital stay was 7.2 days (standard deviation, 5), but it fluctuated from year to year. The mean Medicare payment was $9,210 (standard deviation, 5,587), but it fluctuated over time, consistent with the medical consumer price index.

Discharge placement and mortality. Table 2 summarizes data on discharge placement and mortality after hip fracture. Overall, the majority of patients (58%) were discharged to a nursing facility, with 14% being discharged to their homes. Over time, home and inpatient rehabilitation placements decreased, while nursing facility placements increased. We evaluated inpatient and skilled nursing facility Medicare claims files to determine where patients resided at 90 days and 180 days postdischarge. For patients initially discharged to a nursing facility, half (49%) were at home at 90 days and continued to be there at 180 days (96%). Thirty-four percent of those initially discharged to a nursing facility continued to reside there at 90 days and either remained in a nursing facility at 180 days (81%) or died (17%). Most hip fracture patients discharged to their homes were still at home at 90 days (76%) and 180 days (88%).

Overall, the in-hospital mortality rate was 3%, although as the cohort aged the in-hospital mortality rate rose from 1% to 4%. The 6-month mortality rate was 19% overall, but it also increased over time from 16% to 25%. Similarly, the 1-year mortality rate was 26% overall, but it increased over time from 21% to 31%.

Functional status change. Table 3 shows data on mean functional status changes in ADLs, IADLs, fine motor skills, self-reported health, and depressive symptoms for the 209 respondents with complete information and for the 165 (or 124) cases with complete data on mobility and large muscle group abilities, gross motor skills, and cognitive status. As

Table 1. Characteristics of Hip Fracture Episodes for 495 Hip Fracture Cases, Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD), 1993–2005

Characteristic	No.	%	Mean (SD)
Hip fracture location			
Pertrochanteric[a]	220	44.5	
Femoral neck[b]	163	32.8	
Unspecified[c]	112	22.7	
Secondary diagnoses			
Osteoarthritis and related conditions[d]	118	23.8	
Fall	114	23.1	
Delirium, dementia, and other cognitive disorders	107	21.6	
Fluid and electrolyte disorders	102	20.6	
Surgical and medical complications[e]	59	12.0	
Other fractures[f]	38	7.7	
Vision problems[g]	21	4.2	
Dizziness/vertigo[h]	10	2.0	
Open wounds[i]	7	1.4	
Procedure type			
Hip pinned	273	55.1	
Hip replaced	195	39.3	
No procedure	27	5.5	
Length of stay, days			7.2 (5.0)
Medicare payment, dollars			9,209.86 (5,586.73)

Abbreviations: ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*; SD, standard deviation.

[a] Includes trochanteric (ICD-9-CM code 820.20), intertrochanteric (ICD-9-CM code 820.21), and subtrochanteric (ICD-9-CM code 820.22) fracture.

[b] Includes intracapsular section, unspecified (ICD-9-CM code 820.00), epiphysis (ICD-9-CM code 820.01), midcervical section (ICD-9-CM code 820.02), base of neck (ICD-9-CM code 820.03), and other transcervical fracture (ICD-9-CM code 820.09).

[c] Includes unspecified part of the neck of femur, closed (ICD-9-CM code 820.8).

[d] Includes osteoarthritis, other nontraumatic joint disorders, spondylosis, intervertebral disc disorders, other back problems, osteoporosis, and pathologic fracture.

[e] Includes complications associated with a device, implant, or graft, and complications of surgical procedures or medical care.

[f] Includes skull and face fractures, fracture of the upper limb, fracture of the lower limb, and other fractures.

[g] Includes cataract, retinal detachments, defects, vascular occlusion, retinopathy, glaucoma, blindness, and vision defects.

[h] Includes conditions associated with dizziness or vertigo and other ear and sense organ disorders.

[i] Includes open wounds of the head, neck, and trunk and open wounds of the extremities.

shown, these hip fracture cases had good functional status at their prefracture assessments, with mean ADLs, IADLs, and fine motor skill difficulties all being less than 1. However, their postfracture assessments indicated substantial declines in functional status. Among decliners, this involved increases of 1.9 ADLs, 1.7 IADLs, and 2.2 depressive symptoms, as well as a 34.0-point drop in their self-rated health (where poor = 15 and excellent = 95). In addition, mobility scores worsened by an average of 2.3 out of 5 abilities; large muscle scores worsened by an average of 1.6 out of 4 abilities; gross motor skills worsened by an average of 2.2 out of 4 abilities; and cognitive status declined by 2.5 points out of 15 points.

To assess whether the hip fracture patients not included in the analyses were different from those included, we compared their baseline scores for ADLs, IADLs, fine motor skills, self-reported health, and depressive symptoms. We did this in 2 ways, first comparing included patients with excluded patients overall and then comparing the included patients with 3 categories of excluded patients (those who used proxy respondents, those who were deceased, and those who were lost to follow-up). The only statistically significant difference ($P = 0.04$) involved IADLs, with persons included in the analyses having better baseline functional status (the mean score for those included was 0.34 vs. 0.51 for those not included). Patients excluded because of proxy responses had the worst baseline IADL scores.

We conducted an analysis of the functional status changes of the hip fracture patients with complete pre- and postfracture information from the time period directly prior to the pre-hip-fracture assessment, to evaluate whether hip fracture patients were in declining health during the period prior to the hip fracture. While this reduced our sample sizes somewhat (from 209 patients to 162 patients and from 165 patients to 102 patients), these analyses showed that for fine motor skills, IADLs, ADLs, and gross motor skills, in most patients (76%, 75%, 74%, and 63%, respectively) there was either a pattern of no change or improvement in functional status prior to the hip fracture event, followed by a decline in status after the event or stable function throughout the period (regardless of hip fracture).

Multivariable analyses

Discharge placement. Table 4 shows results from the multinomial regression analysis of discharge placement that contrasted home and inpatient rehabilitation placement with nursing facility placement (the reference group). Three characteristics of the hip fracture were associated with discharge placement—patients with pertrochanteric fractures and patients who had hip replacement surgery were less likely to be transferred to their homes (vs. a nursing facility) and patients with a secondary diagnosis of falls or dementia were less likely to be transferred to inpatient rehabilitation care (vs. a nursing facility). Patients who had only a grade-school education were more likely to be transferred to inpatient rehabilitation (vs. a nursing facility), while patients with health insurance beyond Medicare were less likely to be transferred home. Transfer to a nursing facility was least common in the earliest observation period. Finally, patients who did not undergo surgery were more likely to be transferred to inpatient rehabilitation (vs. a nursing facility). These results were robust when reestimated after removal of the 27 patients who did not undergo a surgical procedure.

Mortality. Table 5 shows results from the proportional hazards regression analysis of time to death after hip

Table 2. Discharge Status and Mortality After Hip Fracture for 495 Hip Fracture Cases, Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD), 1993–2005

Discharge Status	Year of Discharge							
	All Years (n = 495)		1993–1996 (n = 145)		1997–2001 (n = 213)		2002–2005 (n = 137)	
	No.	%	No.	%	No.	%	No.	%
Home	68	13.6	29	20.1	24	11.1	15	10.8
Home/self-care	44	8.9	22	15.2	14	6.4	8	6.0
Home care by organized home health service	21	4.2	7	4.8	9	4.1	5	3.7
Home intravenous drug therapy provider	1	0.3	0	0	1	0.6	0	0
Hospice care	2	0.3	0	0	0	0	2	1.1
Inpatient rehabilitation	128	25.8	44	30.6	50	23.4	34	24.5
Short-term general hospital for inpatient care	15	3.0	7	4.7	4	2.1	4	2.7
Another type of institution for inpatient care	88	17.7	38	26.0	46	21.4	4	3.2
Inpatient rehabilitation facility	24	5.0	0	0	0	0	24	18.0
Long-term acute-care hospital	1	0.2	0	0	0	0	1	0.5
Nursing facility	286	57.9	70	48.2	133	62.6	83	60.7
Skilled nursing facility	266	53.8	61	42.2	127	59.7	78	56.7
Intermediate care facility	15	3.0	9	6.0	6	2.9	0	0
Hospital-based Medicare-approved swing bed	4	1.0	0	0	0	0	4	3.4
Other nursing facility[a]	1	0.1	0	0	0	0	1	0.5
Mortality								
Died in hospital	13	2.7	2	1.1	6	2.8	5	4.1
Died within 6 months of discharge[b]	94	19.0	24	16.3	36	17.0	34	24.9
Died within 1 year of discharge[c]	129	26.0	31	21.1	56	26.2	42	30.9

[a] A nursing facility certified under Medicaid but not certified under Medicare.
[b] Includes in-hospital death.
[c] Includes in-hospital death and death within 6 months.

Table 3. Changes in Functional Status After Hip Fracture in 495 Hip Fracture Cases, Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD), 1993–2005

Functional Status Measure	No. of Subjects	Mean No. of Functional Abilities With Difficulty		Mean Increase in No. of Functional Abilities With Difficulty	% With No Change	% Who Got Worse	Mean No. of Difficulties Among Patients Who Got Worse
		In Wave Before Fracture	In Wave After Fracture				
Activities of daily living	209	0.67	1.54	0.88	41.6	51.2	1.89
Instrumental activities of daily living	209	0.65	1.32	0.67	47.6	44.9	1.68
Fine motor skills	209	0.36	0.65	0.29	59.9	29.3	1.39
Mobility abilities	165	1.70	2.63	0.93	27.8	53.1	2.32
Large muscle group abilities	165	1.49	2.11	0.62	24.7	56.2	1.56
Gross motor skills	165	0.94	1.93	1.00	39.1	51.7	2.16
CES-D symptoms	209	1.86	2.36	0.50	30.2	43.0	2.24
Self-reported health[a,b]	209	60.6	56.1	−4.55	34.3	39.3	34.0
TICS score[b,c]	124	12.9	12.6	−0.27	20.3	43.5	2.46

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; TICS, Telephone Interview to Assess Cognitive Status.
[a] Excellent = 95; very good = 90; good = 80; fair = 30; poor = 15.
[b] Values represent mean decline in health status.
[c] Scores range from 0 to 15 (0 = worst cognition; 15 = best cognition).

Table 4. Adjusted Odds Ratios for Specific Types of Hospital Discharge in 482 Hip Fracture Cases, Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD), 1993–2005

Risk Factor	Model of Discharge Status			
	Home vs. Care Facility		Inpatient Rehabilitation vs. Care Facility	
	Adjusted[a] OR	95% CI	Adjusted[a] OR	95% CI
Characteristics of hip fracture episode				
Length of stay, days	1.03	0.97, 1.09	1.01	0.96, 1.05
Secondary diagnoses				
Dementia	0.63	0.30, 1.32	0.33**	0.17, 0.65
Fall	0.84	0.43, 1.65	0.38**	0.21, 0.71
Pertrochanteric hip fracture	0.41*	0.20, 0.88	1.42	0.72, 2.82
Type of procedure				
Hip pinned (referent)	1.00		1.00	
Hip replaced	0.46*	0.22, 0.99	1.87	0.94, 3.76
No procedure	1.64	0.45, 5.93	3.58*	1.18, 10.8
Sociodemographic factors				
Age at time of hip fracture, years				
69–74 (referent)	1.00		1.00	
75–79	0.47	0.13, 1.72	2.98	0.61, 14.5
80–84	0.39	0.11, 1.33	1.81	0.39, 8.48
≥85	0.36	0.11, 1.22	3.18	0.69, 14.7
Period[b] of hip fracture occurrence				
Early	1.70	0.80, 3.60	2.09*	1.17, 3.76
Middle (referent)	1.00		1.00	
Late	1.14	0.53, 2.45	1.19	0.66, 2.15
Male sex	1.68	0.84, 3.37	0.93	0.50, 1.73
Race/ethnicity				
African-American	1.55	0.45, 5.38	2.04	0.69, 6.01
Hispanic	1.54	0.30, 7.81	1.80	0.45, 7.16
White (referent)	1.00		1.00	
Lived alone[c]	1.05	0.57, 1.93	1.25	0.77, 2.02
Socioeconomic factors				
Education				
Grade school	1.61	0.78, 3.33	2.58**	1.44, 4.63
High school (referent)	1.00		1.00	
College	0.94	0.44, 1.98	1.48	0.82, 2.68
No. of health insurance policies	0.59*	0.35, 0.99	1.17	0.81, 1.67
Health and functional status				
No. of comorbid conditions at baseline				
0	1.56	0.75, 3.23	1.16	0.61, 2.19
1–2 (referent)	1.00		1.00	
>2	0.61	0.28, 1.34	1.14	0.64, 2.01
Self-reported health fair to poor[c]	1.11	0.58, 2.10	1.26	0.77, 2.08
ADL index score[c]	1.13	0.89, 1.44	1.10	0.90, 1.35
TICS score[c]				
13–15 (good cognition)	1.10	0.54, 2.26	1.45	0.81, 2.58
Missing data	0.68	0.32, 1.47	0.83	0.46, 1.51

Abbreviations: ADL, activities of daily living; CI, confidence interval; OR, odds ratio; TICS, Telephone Interview to Assess Cognitive Status.

* $P < 0.05$; ** $P < 0.01$.

[a] Results were adjusted for all of the characteristics in the table.

[b] Early period: within 3.5 years of the baseline interview; middle period: 3.5–7.2 years after the baseline interview; late period: more than 7.2 years after the baseline interview.

[c] Assessed at the time of the closest survey prior to the hip fracture.

Table 5. Adjusted Hazard Ratios for Mortality in 495 Hip Fracture Cases, Survey on Assets and Health Dynamics Among the Oldest Old (AHEAD), 1993–2005

Risk Factor	Adjusted[a] Hazard Ratio	95% Confidence Interval
Characteristics of hip fracture episode		
Secondary diagnoses		
Osteoarthritis and related conditions	0.71*	0.54, 0.94
Dementia	1.45**	1.10, 1.90
Surgical or medical complications	1.33	0.96, 1.83
Pertrochanteric hip fracture	1.04	0.78, 1.40
Type of procedure		
Hip pinned (referent)	1.00	
Hip replaced	1.10	0.81, 1.50
No procedure	3.49***	2.18, 5.58
Sociodemographic factors		
Age at time of hip fracture, years		
69–74 (referent)	1.00	
75–79	1.21	0.62, 2.36
80–84	1.64	0.87, 3.11
≥85	1.96*	1.04, 3.69
Male sex	1.51**	1.16, 1.98
Race/ethnicity		
African-American	0.95	0.57, 1.59
Hispanic	0.92	0.48, 1.74
White (referent)	1.00	
Socioeconomic factors		
Education		
Grade school	0.90	0.68, 1.18
High school (referent)	1.00	
College	1.04	0.79, 1.38
No. of health insurance policies	0.93	0.77, 1.12
Health and functional status		
No. of comorbid conditions at baseline		
0	1.04	0.76, 1.41
1–2 (referent)	1.00	
>2	1.65***	1.26, 2.18
Self-reported health fair to poor[a]	1.19	0.93, 1.51
ADL index score[b]	1.04	0.94, 1.14
TICS score[b]		
13–15 (good cognition)	0.81	0.62, 1.07
Missing data	1.27	0.97, 1.68

Abbreviations: ADL, activities of daily living; TICS, Telephone Interview to Assess Cognitive Status.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

[a] Results were adjusted for all of the variables listed in the table.

[b] Assessed at the time of the closest survey prior to the hip fracture.

fracture. Men were 51% more likely to die than women. Persons who were aged 85 years or older at the time of their hip fracture were 96% more likely to die than patients who were aged 69–74 years. Patients with 3 or more comorbid conditions were 65% more likely to die than those with fewer conditions. Patients with secondary diagnoses of osteoarthritis were 29% less likely to die, while patients with dementia were 45% more likely to die. Mortality risk was 249% greater for patients who did not undergo surgery. Results were robust when reestimated after removal of the 27 people who did not undergo a surgical procedure. Finally, when a time-dependent covariate for hip fracture was added to a standard mortality model among all 5,511 AHEAD participants (data not shown), net mortality risk was twice as high after hip fracture (adjusted hazard ratio = 1.98, $P < 0.001$).

Functional status change. Although functional status decline following hip fracture was widespread (see Table 3), multivariable linear regression revealed that the amount of that decline was not consistently associated with characteristics of the hip fracture or of the patient (data available upon request). For example, only a positive response to the CAGE (41) ''cut-down'' question among current drinkers of alcohol, length of stay, high income, and age were significantly associated with amount of change in 3 or more of the functional status measures. Alcohol drinkers who expressed the need to ''cut down'' had significantly larger decrements in IADLs (score change: 0.63), fine motor skill deficits (score change: 0.65), and depressive symptoms (score change: 1.46). Longer lengths of stay reduced large muscle and gross motor skill declines, and being in the upper income quintile reduced the amount of decline on the mobility, large muscle, and gross motor skills scales. Being in one of the 2 oldest age groups reduced the amount of decline in mobility and gross motor skills, while actually improving cognitive status.

DISCUSSION

In this study, we found that most hip fracture patients (58%) were discharged to a nursing facility, which is significantly higher than the 25%–35% reported by other investigators (42, 43). However, when we evaluated placement at 90 days and 180 days for those patients initially discharged to a nursing facility, half (49%) were at home at 90 days and were also there at 180 days (96%). Thus, even though many hip fracture patients are initially discharged to a nursing facility, long-term stays are uncommon, with most patients returning to their homes within 90 days. These results suggest that evaluation of the entire hip fracture episode of care provides a more complete picture of the aftermath and should be considered when identifying ways to reduce morbidity and mortality. Initial discharge to home and inpatient rehabilitation decreased over time, while nursing facility placements increased. These trends reflect 2002 changes in Medicare reimbursement policies (28) and the aging of the AHEAD cohort. The absence of entries in Table 2 for 2 of the inpatient rehabilitation categories (inpatient rehabilitation and long-term acute care hospitals) and 2 of the nursing facility categories (swing beds and other nursing

facilities) from 1993 to 2001 also reflects those Medicare policy changes.

In-hospital mortality was 2.7%, which is close to a recent report of 1.6% but somewhat lower than the 4%–5% found in older reports (12, 14, 44). These differences probably reflect shortened hospital stays resulting from the implementation of the prospective payment system (45). Our 6-month mortality rates (19%) were substantially higher than the 12%–14% previously reported for 6-month mortality (14, 16). Of note in our multivariable analyses of mortality are the strong effects of frailty, age, and dementia on postfracture mortality. While these results concur with those of prior reports (12, 13), measures of self-reported health and cognition were not statistically significant predictors when evaluated concurrently with claims-based assessments of cognitive status (admission diagnoses).

The most important contribution of this study is its prospective objective assessment of change in functional status. To our knowledge, no other study on the aftermath of hip fracture has had functional status self-assessments obtained prior to the experience of hip fracture without retrospective reporting bias. Meaningful functional status declines after hip fracture were common and substantial. To provide perspective, we compared the functional status changes of hip fracture patients to the average wave-to-wave within-person changes among AHEAD participants who did not experience hip fracture. The results demonstrated that the functional decline of hip fracture patients was generally 3 times larger than that for non-hip-fracture patients. Thus, while it is important to identify ways to prevent hip fracture in older adults, it is equally important to address the functional needs of hip fracture patients.

Although our sample was nationally representative and comparable in size to those of several recent cohort reports, we had smaller samples in our assessment of functional status changes. This was due to the considerable 1-year postfracture mortality and the increased use of proxy respondents at postfracture interviews. Therefore, our functional status change results probably underestimate the impact of hip fracture, because our sample probably contained only the healthiest and least impaired subset of hip fracture patients.

As Table 3 shows, while declines in functional status after a hip fracture were substantial, a potential limitation to the interpretation of these results is whether persons who suffered a hip fracture were in declining health prior to their hip fracture. Declining functional status could have led to the hip fracture event. However, based on our post-hoc analysis of functional status during the time period prior to the hip fracture, the marked declines in functional status after a hip fracture were most likely due to the hip fracture event and not to pre-hip-fracture declines.

Our study was not without limitations. In addition to the functional status sample size issues, we did not use a control group in the traditional sense. Instead, we relied on having pre- and post-hip-fracture data and using each patient as her or his own control. Finally, although we used reliable and valid measures of functional status pre- and post-hip-fracture, no clinical performance measures were available to provide more granular assessments.

In conclusion, our results suggest that previous studies may not have fully captured the deleterious effect of hip fracture on discharge placement, functional status, and mortality. While additional efforts to avoid hip fracture and limit its adverse effects continue to be needed, efforts to identify the recuperative needs of hip fracture patients are also important for the successful aging of older adults.

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